

## Report on Tornado & Severe Thunderstorm 19, December 2009

### Timeline of the warnings issued during the lead up to the severe weather

The Bermuda Weather Service issued a series of warnings leading up to Saturday, 19<sup>th</sup> of December.

- **Tuesday December 15<sup>th</sup>** Thunderstorms had been forecast by BWS for Saturday the 19<sup>th</sup> since when Saturday featured as our Day 5 in our five day forecast, and remained in the forecast for the full 5 days.
- **5:30 December 17<sup>th</sup>** Gale force winds (up to sustained 35 knots) with Storm force gusts (50 knots) were forecast for Saturday.
- **16:30 December 17<sup>th</sup>** a Gale Warning was issued for Saturday (36 hours ahead of the gales)
- **14:45 December 18<sup>th</sup>** BWS Director sent out an email to EMO with the following details...

“Just as a heads-up, in association with tomorrow's gale force winds, we are expecting sustained winds of around 35 knots and wind gusts in excess of 50 knots, from the south; this is especially valid for elevated & exposed locations. The strongest wind gusts are expected to be associated with heavy showers and thunderstorms, especially in the Marine Area, at any time mainly during the period 11am through 5pm. For this reason, we may post a Severe Thunderstorm Watch tomorrow morning, dependent on the level of development of the thunderstorms. At this time, it is not expected that there will be any tornadoes or hail associated with these thunderstorms. “

- **16:30 December 18<sup>th</sup>** a Thunderstorm Advisory was issued valid for Saturday.
- **12:30 December 19<sup>th</sup>** MIDS & Radar was showing signs of organized thunderstorms in distance
- **13:23 December 19<sup>th</sup>** Radar image showed signs of rotation 180 km to the west – Duty forecaster calls Deputy Director to discuss. It is agreed that if they show signs of strengthening, a Severe Thunderstorm Warning will need to be issued.
- **13:50 December 19<sup>th</sup>** Duty forecaster calls Deputy Director to discuss issuing a Severe Thunderstorm Warning. Agreed by both parties. The Duty Forecaster composes the warning and the forecast to be issued at 14:30. (figure 3)
- **14:30 December 19<sup>th</sup>** a Severe Thunderstorm Warning was issued valid for Saturday Afternoon & Evening.
- **14:35 December 19<sup>th</sup>** Lightning & thunder observed in central parishes (Deputy Director)
- **14:39 December 19<sup>th</sup>** The Director sent an email to EMO with the following details....

“The Duty Forecaster is issuing a Severe Thunderstorm Warning to cover this afternoon (around 3pm to 5pm local time). He is also giving COMOPS, Air Traffic Control and Bermuda Radio a heads up. This is to cover the eventuality that the developing severe thunderstorm activity (two large cells currently 80km and 120km to our west) will affect the island and Marine Area. Just as a reminder, Severe Thunderstorms can produce Hail >3/4 inch gusts in excess of 50 knots, and/or tornadoes. Looks like the nearer cell will go to our north, but the second cell may clip the island.”

- **14:55 December 19<sup>th</sup>** Thunderstorm observed at airport.
- **15:45 December 19<sup>th</sup>** Reports of damage at Devonshire Bay (figure 7)
- **16:00 December 19<sup>th</sup>** Reports of roof damage in the Cavendish Heights area
- **16:15 December 19<sup>th</sup>** Reports of trees down in Hamilton City (figure 6)
- **16:30 December 19<sup>th</sup>** the Severe Thunderstorm Warning was downgraded to a Watch until the evening.
- At the airport the precipitation total for this system was 0.99”; the highest sustained winds were 35 knots with a peak gust of 45 knots at 16:34 local time. The highest winds recorded by our

AWOS sensors were 49 knots gusting 66.3 knots at Commissioner's Point at 15:20-1530 local time.

- A Severe Thunderstorm Warning was issued on Saturday 19<sup>th</sup> December, 2009 in response to evidence of rotation aloft on the Doppler radar imagery. As soon as the Warning was issued, BWS notified the EMO, Bermuda Maritime Operations Centre, the Air Traffic Control Tower and the Police Communications and Operations Command Post, as per our standard operating procedures. The conditions which warrant such a warning are: wind gusts of 50 knots or greater, hail of diameter 3/4 inch or greater and/or tornadoes.

### Details of Assessment

Both the Deputy Director and Director went to the damage report areas; highlights of the survey and talks with witnesses are detailed below.

At **Devonshire Bay** several tree branches were blown down (figure 7), all facing the same direction, NNE from the point of origin. A small cedar tree was snapped off three feet from the base. Minor structural damage occurred as a fence was blown off at 14 Devonshire Bay Rd. The residents of #14 mentioned that the casuarina trees affected by this wind damage had withstood several hurricanes, including Fabian. This evidence supports the idea of a large short-term increase in wind speed (i.e. the suddenness of a squall or a microburst).

In the **City of Hamilton** the first evidence of damage were large limbs of trees strewn across Reid Street. (Figure 6.) Power lines were down outside of Chopsticks; the roof on the main entrance to Magistrates Court (corner of Parliament and Reid Streets) was damaged and covered by tarpaulin by the time we got there (around 5:30pm). Buildings Superintendent Stephen Tucker (Min of W&E) indicated that it was likely because of the impact of debris/missiles carried in the wind, rather than direct damage done by the wind itself. Pedestrians and motorists had dragged lots of large tree branches off the road and onto the sidewalks along Reid St, from Parliament St. to Burnaby Hill to enable traffic to flow through the city. However there were some that were too heavy to lift and thus were broken down into manageable pieces by chainsaw. Some large limbs had fallen onto bikes, knocking them over, or otherwise trapping them and making them inaccessible to their owners to remove. There were unconfirmed reports of parked bikes on Reid St. being scattered by the wind, and two cars being heavily damaged by tree branches (one by the General Post Office), but not in evidence when we got there (perhaps towed/driven away already). The building next to Chancery Lane had some roof damage (20 X 5 feet according to high-lift & truck operator, who was assisting in the securing of the roof). Apparently the area around Joell's Alley took some damage also (unconfirmed). The Coconut Rock building had one pane of their west-facing atrium windows (top floor) blown/impacted in. Later we had a witness contact us to say that there was damage to the new HSBC building under construction and that the debris landed on top of the Royal Gazette building and the balcony of the Bank of Butterfield.

The general impression was that there was no evidence of rotation in the damage pattern - most of the debris was oriented SSW/NNE in Hamilton, and the only debris that had no discernible pattern was in a courtyard, the shape of which could have disturbed the background flow. Evidence at this point suggested more of a straight-line wind event, supporting this is the fact that no witnesses

described seeing a funnel cloud, but more so they indicated a direction from which the event occurred (SW).

During Sunday 20<sup>th</sup> December further investigation was carried out along **Pitts Bay Road**, by the Deputy Director (figures 4 & 5). It was at these homes that evidence of rotation in the debris field was observed. Large chunks of the roof (not able to be picked up by a man) were found in an outside stairway approximately 20 feet W through NW of the origin. A straight line wind would have scattered the debris to the NE. A blind in the lee side of the red house was twisted off leaving a fraction of it still attached to a hinge (see photo). The push-out hook for the blind was located not only on top of the roof but south of the window of origin. Teak table and chairs on the S side of the house were scattered around the E through N side of the building. A large tree limb was oriented in a SE through NW direction. A quick glance at the weather sensor data from the Davis instruments on Hinson's Island showed a peak wind of 64 knots over a 5 minute time span around the time of the suspected tornado, and a rapid drop in pressure (see Figure 8.)

Various residents of the **First Avenue, Cavendish Heights** area reported porch roof damage as well as large limbs being strewn in a W to E direction, even the top of a palm tree being blown off and found three houses away. Thankfully, there were no reports of injury.

The conclusion based on our analysis of the Doppler radar data, the survey of damage and the input from various members of the public, is that this feature approached the northwest through north of Hinson's Island, came onshore at Pitts Bay Road as a tornado, travelled towards Reid Street, probably had a modified surface wind field due to the friction of buildings thus acted like a straight line wind even due to the tunnelling of the wind down Reid Street, as it hit Cavendish Heights it could have had rotation at that elevation (not certain as debris did not confirm this). It looks like the damage at Devonshire Bay was from a different thunderstorm cell based on the paths of the cells and timing of damage. This most likely was due to straight line winds as the debris is orientated in line with the forecast and observed wind direction, from SW to NE. It is difficult to judge the category of tornado due to the standard descriptions of damage being related to United States building structures, and Bermuda roof construction is extremely different. It would require less force to tear off a US style roof compared with Bermuda construction. As it stands I can estimate the tornado to have been between EF1 and EF2 due to these categories claiming "Heavy roof damage to homes and businesses, large tree limbs snapped off".

It is worth noting that from a forecasting perspective this was a success. Thunderstorms had been forecast for Saturday five days previous, a Thunderstorm Advisory was issued 23 hours in advance of the first thunderstorm, a Severe Thunderstorm Advisory was issued an hour before the tornado hit Pitts Bay Road and all agencies (EMO, COMOPS, RCC Bermuda HR, ATC) were given the heads up 24 hours before and the warning 1 hour prior to event. Everything was issued in accordance with our SOPs.

Unfortunately, the Severe Thunderstorm Warning only reaches those members of the public who are diligent enough to occasionally monitor our website, call BTC lines, watch BWS weather information on CV or WOW channels or tune in to VHF Channel 2. BWS are continuing to examine additional methods of information dissemination, to help ensure urgent weather information reaches as much of the general public and in as timely a manner as possible.



Figure 1: Path of suspected tornado and locations of resulting damage in Hamilton



Figure 2: Path of suspected tornado and locations of resulting damage in Devonshire Bay

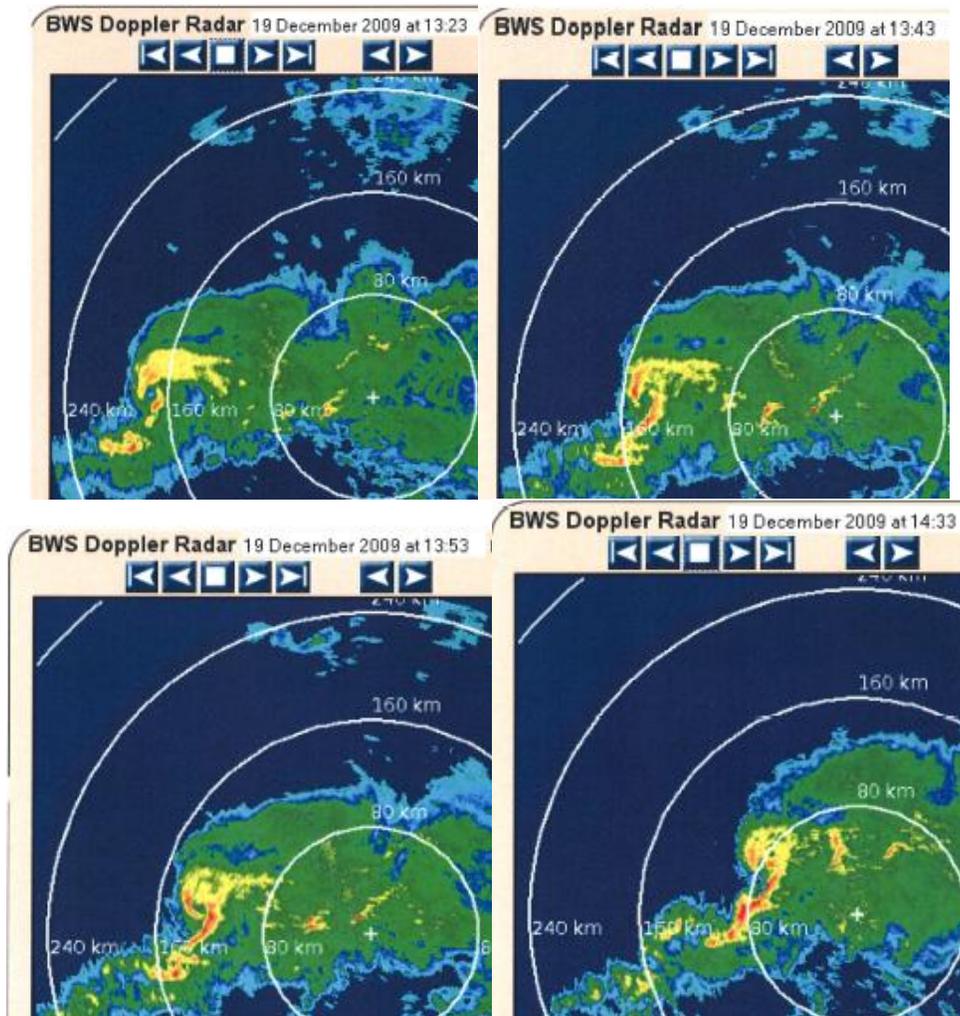


Figure 3: Watching the rotation form on the thunderstorms 180 km west of Bermuda (times are local times)

Please review the loops below that detail the tornado passage over Bermuda.

The Doppler Radar PPI animation can be found at [\\serbasnew\met\Case Studies\2009\\_19Dec\\_Svre Tstrm & Tornado\Radars\\_100km\\_V\radaranimation.htm](\\serbasnew\met\Case Studies\2009_19Dec_Svre Tstrm & Tornado\Radars_100km_V\radaranimation.htm)

The Doppler Radar SRI animation can be found at [\\serbasnew\met\Case Studies\2009\\_19Dec\\_Svre Tstrm & Tornado\Radars\\_100km\\_SRI\radaranimation.htm](\\serbasnew\met\Case Studies\2009_19Dec_Svre Tstrm & Tornado\Radars_100km_SRI\radaranimation.htm)



Figure 4: Roof damage at Pitts Bay Road, Hamilton, Pembroke



Figure 5: Evidence of rotation: torn blinds on the lee side of Pitts Bay Rd House, Blind hook found on TOP of house (behind and above original location), chunks of roof found 20ft SW of origin



Figure 6: Fallen Tree Limbs, Reid Street, Hamilton, Pembroke



Figure 7: Fallen Trees, Devonshire Bay, Devonshire

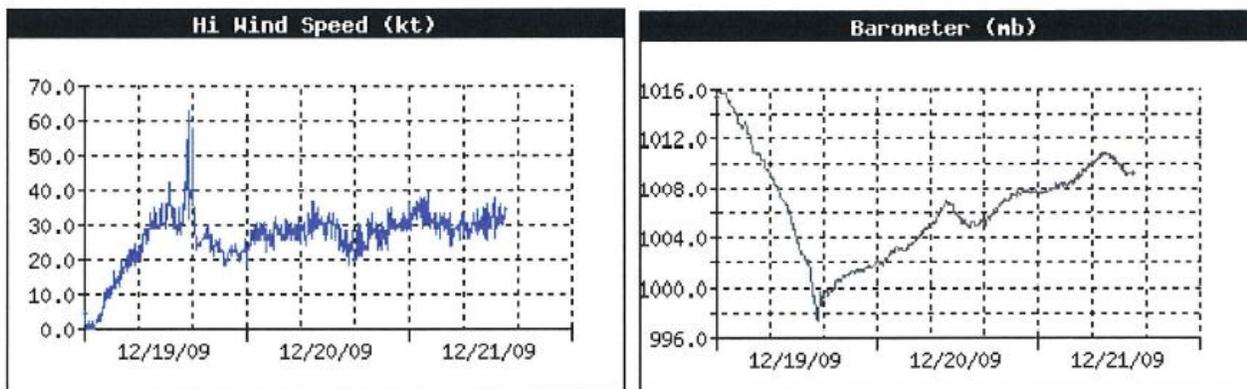


Figure 8: Data from Davis weather instruments on Hinson's Island

Bermuda Weather Service personnel involved in the compilation of this report:

- Nicole Hannon, Meteorological Forecaster
- Ken Smith, Meteorological Forecaster
- Ian Currie, Systems and Database Administrator
- Dr. Mark Guishard, Director
- Kimberley Zuill Deputy Director
- Kevin Zuill, Meteorological Technician